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MINISTRY OF WORKS, HOUSING AND SUPPLY

(Central Boilers Board)

NOTIFICATION

New Delhi, the 1st May, 1961

G.S.R. 632.—The following draft of certain regulations further to amend the Indian Boiler Regulations, 1950, which the Central Boilers Board proposes to make in exercise of the powers conferred by section 28 of the Indian Boilers Act, 1923 (5 of 1923), is published as required by sub-section (1) of section 31 of the said Act, for the information of all persons likely to be affected thereby; and notice is hereby given that the said draft will be taken into consideration on or after the 1st August, 1961.

Any objection or suggestion which may be received from any person with respect to the said draft before the date so specified will be considered by the Central Boilers Board. Such objections or suggestions should be addressed to the Secretary, Central Boilers Board, Ministry of Works, Housing & Supply, North Block, New Delhi.

Draft Regulations

1. These regulations may be called the Indian Boiler (Amendment) Regulations, 1961.

2. In the Indian Boiler Regulations, 1950—

(1) in regulation 4,—

(i) in clause (c) (v)—

(a) after the words 'forged drums' the words 'and headers' shall be inserted;

(b) the following shall be inserted at the end as third paragraph, namely:—

"In addition, certificates in respect of yield point at service temperature (0.2 per cent proof stress), the average stress to produce an elongation of 1 per cent (creep) in 100,000 hours and the average and the lowest stresses to produce rupture in 100,000 hours in the material, wherever is applicable, are to be furnished.";

(ii) after sub-clause (v) of clause (c), the following sub-clause shall be inserted, namely:—

"(vi) For tubes and pipes subjected to internal pressure, a certificate giving results of tests regarding chemical analysis, warm yield point (0.2 per cent proof stress), the average stress to produce an elongation of 1 per cent (creep) in 100,000 hours and the average and the lowest stresses to produce rupture in 100,000 hours in the material wherever applicable, shall be furnished.";

(iii) in clause (e), the following paragraph shall be inserted at the end, namely:—

"And, in addition, information containing results of tests for the material regarding warm yield point (0.2 per cent proof stress), the average stress to produce an elongation of 1 per cent (creep) in 100,000 hours and the average and the lowest stresses, to produce rupture in 100,000 hours wherever applicable are to be furnished.";

(2) For the heading above regulation 36, the following heading, namely,—

"COLD DRAWN SEAMLESS STEEL BOILER AND SUPERHEATER TUBES FOR DESIGN METAL TEMPERATURES NOT EXCEEDING 427 DEGREE C. (800 DEGREE F.)" shall be substituted;

(3) In the note under regulation 36(a), the words figures, letters & brackets and not exceeding 850 degree F. (454 degree C.), shall be omitted; and the word "steam" shall also be omitted from the first line of the note;

(4) for the heading above regulation 43, the following shall be substituted, namely:—

"HOT FINISHED SEAMLESS CARBON STEEL BOILER AND SUPER-HEATER TUBES FOR DESIGN METAL TEMPERATURES NOT EXCEEDING 427 DEGREE C. (800 DEGREE F.)";

(5) for clause (a) of regulation 43, the following clause shall be substituted, namely:—

(a) *Material*.—The tubes shall be seamless and made of steel produced by an Open Hearth or Electric Process, acid or basic, and shall be certified as such by the maker. The chemical composition of the material of the tubes shall conform to the following analysis:—

Chemical Composition (ladle analysis)

**Carbon	0.25% maximum
Silicon	0.35% maximum
Manganese	0.30% maximum
Phosphorous	0.05% maximum
Sulphur	0.05 % ¹ maximum

These provisions cover two quality group of steels, namely, grade 1 and grade 2 depending on their tensile properties.";

(6) for clause (a) of regulation 44, the following clause shall be substituted, namely:—

"(a) *Tensile test*.—Test pieces cut from the ends of annealed portion removed from the ends of the selected tubes shall comply with the following requirements:—

The test may be carried out on test pieces cut out from the tube in the longitudinal direction, which shall not be further heat treated nor straightened within the gauge length. As an alternative, tubes may be tested on full cross section.

Kind of Steel	tensile strength minimum		*elongation on $\frac{L_0 = 5d_0}{L_0 = 5.65 \sqrt{A_0}}$ or % minimum
	kg/mm.	tons/sq. in.	
Grade 1	31.5	20	25
Grade 2	42	27	21

*(i)

L_0 = original gauge length ;
 d_0 = original diameter and ;
 A_0 = original area of cross section.

** (ii)

A carbon content not exceeding 0.35% may be permitted subject to the approval of the Inspecting Authority." ;

(7) for the heading above regulation 47, the following shall be substituted, namely:—

“SEAMLESS MOLYBDENUM STEEL BOILER AND SUPER HEATER TUBES FOR DESIGN METAL TEMPERATURES NOT EXCEEDING 510 DEGREE C. (950 DEGREE F.).”

(8) for clause (a) of regulation 48, the following clause shall be substituted, namely:—

“(a) *Material*.—The tubes shall be manufactured from steel produced by the Open Hearth or Electric processes and shall conform to the following limits of chemical composition:—

Chemical Composition (ladle analysis)

Carbon	0.20% maximum
Silicon	0.10 to 0.45%
Manganese	0.35 to 0.80 %
Phosphorus	0.05% maximum
Sulphur	0.05% maximum
Molybdenum	0.25 to 0.65%

The steelmaker shall prove to the satisfaction of the Inspecting Authority that the quality of the steel is of the required high temperature creep strength.”;

(9) for clause (a) of regulation 49, the following clause shall be substituted, namely:—

“(a) *Tensile Test*.—Test pieces cut from the ends of the selected tubes shall comply with the following requirements. The test may be carried out on the test pieces cut out from the tube in the longitudinal direction which shall not be further heat treated nor straightened within the gauge length. As an alternative, tubes may be tested on full cross section.

Kind of Steel	Tensile Strength minimum		*elongation on $L_0 = 5d_0$ or $L_0 = 5.65 \sqrt{A_0}$ % minimum
	kg/mm.	tons/sq.in.	
Molybdenum Steels	37.5	24	22

**Note*

L_0 = original gauge length ;

d_0 = original diameter and

A_0 = original area or cross section” ;

(10) for the heading above regulation 52, the following shall be substituted, namely:—

“SEAMLESS CHROMIUM-MOLYBDENUM STEEL BOILER AND SUPER-HEATER TUBES FOR DESIGN METAL TEMPERATURES NOT EXCEEDING 538 DEGREE C. (1,000 DEGREE F.).”

(11) in regulation 53,—

(i) for clause (a), the following clause shall be substituted, namely:—

“(a) *Material*.—The tubes shall be manufactured from steel produced by the Open Hearth or Electric processes and shall conform to the following limits of chemical composition:—

Chemical composition (ladle analysis)

Carbon	0.18% maximum
Silicon	0.10 to 0.60%
Manganese	0.35 to 0.70%
Phosphorus	0.05% maximum
Sulphur	0.05% maximum
Chromium	0.7 to 1.25%
Molybdenum	0.4 to 0.7% .

The steelmaker shall prove to the satisfaction of the Inspecting Authority that the quality of the steel is of the required high temperature creep strength.”;

(ii) for clause (b), the following clause shall be substituted, namely:—

“(b) *Heat treatment*.—The tubes shall be fully annealed or normalised and tempered, at a temperature approved by the Inspecting Authority.”;

(12) for clause (a) of regulation 54, the following clause shall be substituted, namely:—

“(a) —Tensile Test:

Test pieces cut from the end of the selected tubes shall comply with the following requirements. The test may be carried out on the test pieces cut out from the tube in the longitudinal direction which shall not be further heat treated nor straightened within the gauge length. As an alternative, tubes may be tested on full cross section.

Kind of Steel	Tensile strength minimum		*Elongation on $L_0 = 5 d_0$ or $L_0 = 5.65 \sqrt{A_0}$ % minimum
	kg/mm.	tons/sq.in.	
Chromium-Molybdenum Steels	39	25	20

*Note L_0 —original gauge length
 d_0 —original diameter
 A_0 —original area of cross section.

(13) After regulation 56, the following regulation shall be inserted, namely:—

“56A: SEAMLESS CHROMIUM-MOLYBDENUM STEEL BOILER AND SUPERHEATER TUBES FOR DESIGN METAL TEMPERATURES NOT EXCEEDING 577°C. (1070°F).”

(i) *General*.—The provisions of this regulation apply to both Hot Finished and Cold Drawn seamless Boiler and Superheater Tubes which shall conform in all respects with the requirements herein specified.

(ii) *Material*.—The tubes shall be manufactured from steel produced by the open Hearth or electric processes and shall conform to the following limits of chemical composition:—

Carbon	0.15% maximum
Manganese	0.30 to 0.70%
Silicon	0.1 to 0.50%
Phosphorus	0.04% maximum
Sulphur	0.04% maximum
Chromium	1.90 to 2.6%
Molybdenum	0.87 to 1.2%

The steelmaker shall prove to the satisfaction of the Inspecting Authority that the quality of the steel is of the required high temperature Creep Strength.

(iii) *Heat Treatment*.—The tubes shall be fully annealed or normalised and tempered, at a temperature approved by the Inspecting Authority.

(iv) *Workmanship and tolerance*.—The tubes shall be well finished, clean and free from harmful defects. They shall be reasonably straight, smooth, cylindrical and subject to the following tolerance before bending.

(a) *Diameter*.—The external diameter of the tubes measured at any point shall be within the following tolerances of the diameter specified:—

Type of Tube	Outside Diameter of Tube	Tolerance
Hot finished	Upto and including 64 mm. ($2\frac{1}{2}$ in.)	—0.4mm. ($1/64$ ") +0.8mm. ($1/32$ ")
Hot finished	Over 64 mm. ($2\frac{1}{2}$ in.)	+1% —1%
Cold drawn	All sizes	+0 —1%

(b) *Thickness*.—The thickness of the tubes shall be within the following tolerances:—

Type of Tube	Outside Diameter of Tube	Tolerance
Hot finished	Upto & including 64 mm. ($2\frac{1}{2}$ ")	+17½% —7½%
	Over 64 mm. ($2\frac{1}{2}$ ")	+15% —5%
Cold drawn	All sizes	—10% —5%

Where the ends of the tubes are swelled or reduced, the thickness at the ends may be decreased below or increased above the nominal thickness of the tubes by an amount in proportion to the percentage of such swelling or reduction, and in addition to this allowance, the tolerances relating to thickness shall also apply. Swelling or reduction shall be carried out before the heat treatment specified in Regulation 56A (iii).

(c) *Length*.—The tubes shall be not less than the nominal length but may exceed it by the amount given below:—

Upto & including 9 meters (30 ft.)	—3 mm. ($1/8$ ")
Over 9 meters (30 ft.)	—6 mm. ($1/4$ ")

(v) *Selection of Tubes for testing*.—After heat treatment, the tubes shall be presented for mechanical testing in accordance with the Regulations 56A(vi), 56A(vii) and 56A(viii), in batches of not more than 100 of the same nominal diameter and thickness. The manufacturer shall provide at his own expense extra tubes at the rate of 2 per cent. of each diameter and thickness of tube specified and the Inspecting Officer shall select for test such of the tubes as he may think proper to the extent of the percentage mentioned. Should the number of tubes specified of any one nominal size exceed 400, then, for every 100 tubes or part thereof above that number, one additional tube shall be provided. The samples for testing shall not be heat treated after selection.

(vi) *Tensile Test*.—Test pieces cut from the ends of the selected tubes shall comply with the following requirements:—

The tests may be carried out on test pieces cut out from the tube in the longitudinal direction which shall not be further heat treated nor straightened within the gauge length. As an alternative, tubes may be tested on full cross section.

Kind of Steel	Tensile strength minimum		*elongation on $L_0 = 5d_0$ or $L_0 = 5.65 \sqrt{A_0}$ % minimum
	kg/mm ²	Tons/sq. in.	
Chromium Molybdenum Steel	39	25	20

*Note :

L_0 = original gauge length

d_0 = original diameter and

A_0 = original area of cross section.

(vii) *Flattening Test*.—A ring not less than 51mm. (2 inches) in length cut from one end of each selected tube shall be flattened between two parallel flat surfaces, the width of which shall be not less than $1\frac{1}{2}$ times the diameter of the tube. When the pressure is released, the interior surfaces of the test pieces (at the middle) shall remain at a distance apart of not more than three times the specified thickness of the tube and the test piece shall then show no sign of crack or flaw.

Flattening test carried out in accordance with any other standard code may be accepted in which case, the code adopted shall be specified.

(viii) *Expanding Tests*.—The tubes shall withstand expanding by a drift expander having a total included angle of between 40° and 60° (20° and 30° per side) to the following increases in external diameter without showing crack or flaw:—

Thickness of tube	Increase in Diameter per cent
3mm. (0.128") and thinner	12½
Thicker than 3 mm. (0.128") upto and including 5 mm. (0.192")	9½
Thicker than 5mm. (0.192")	6½

In lieu of expanding test as above, flaring test carried out in accordance with any other standard Code may be accepted in which case, the Code adopted shall be specified.

(ix) *Additional Tests before rejection*.—Should a tube selected for testing purposes show definite signs of failure in any one or more of the tests specified in clauses (vi), (vii) and (viii), two further tests of the same kind may be made at the option of the manufacturer from two additional selected tubes. If the repeat tests are satisfactory, the tubes shall be accepted provided that in all other respects they fulfil the conditions of these Regulations. Should either of the tubes fail in any test, the batch of tubes represented may be re-heat-treated in accordance with clause (iii) and then re-tested in accordance with clauses (vi), (vii) and (viii) but employing twice the number of test pieces.

If the second repeat tests are satisfactory, the tubes shall be accepted provided that in all other respects they fulfil the conditions of this standard; but if definite defects are again shown, the batch of tubes which the test pieces represent shall be rejected.

(x) Each tube shall be tested at the makers work's and shall withstand a hydraulic pressure of $1\frac{1}{2}$ times the design pressure, subject to a minimum of 70 kg/sq. cm. (1000 lbs. per square inch).";

Mechanical Properties at 20°C (68°F)

Kind of Steel	Tensile strength minimum		*elongation on $L_0 = 5 d_0$ or $L_0 = 5.65 \sqrt{A_0}$ % minimum
	kg./mm.	tons/sq.in.	
Carbon Steels			
(1)	35	22	22
(2)	38.5	24.5	21
(3)	41	26	20
(4)	44	28	19
(5)	47	30	18
Manganese Steels			
(1)	47	30	18
(2)	52	33	16
Molybdenum Steels	44	28	19
Chromium-Molybdenum Steels	42	27	20

*Note —

L_0 = original gauge length ;
 d_0 = original diameter and
 A_0 = original area of cross section.

Note: A range of not more than 20% of the minimum tensile strength shall be permitted in each class of material."

(16) for the heading above regulation 244, the following shall be substituted, namely:—

"TUBES, PIPES IN BOILERS, HEADERS AND STEEL CASTINGS"

(17) for clause (b) of regulation 244, the following clause shall be substituted, namely:—

"Pipes—(b): Pipes forming an integral part of the boiler unit shall comply with the provisions of Chapter VIII.";

(18) for regulation 245, the following regulation shall be substituted, namely:—

"245. *Headers.*—Headers and similar pressure parts shall be of forged steel, seamless steel pipes or of cast steel and shall comply with the relevant provisions of Chapter II, in all other respects excepting the chemical composition, tensile strength and elongation of the respective materials, which shall comply with the following, as may be applicable:—

*Chemical Composition (Ladle analysis)****Carbon Steels*

Carbon	0.25% maximum
Silicon	0.35% maximum
Manganese	0.30% maximum
Phosphorus	0.05% maximum
Sulphur	0.05% maximum

**A carbon content not exceeding 0.35% may be permitted, subject to the approval of the Inspecting Authority.

Manganese Steels

Carbon	0.23% maximum
Silicon	0.20 to 0.60%
Manganese	0.90 to 1.30%
Phosphorus	0.05% maximum
Sulphur	0.05% maximum

Molybdenum Steels

Carbon	0.20% maximum
Silicon	0.10 to 0.45%
Manganese	0.35 to 0.80%
Phosphorus	0.05% maximum
Sulphur	0.05% maximum
Molybdenum	0.25 to 0.65%

Chromium-Molybdenum Steels

(1) Carbon	0.18% maximum
Silicon	0.10 to 0.60%
Manganese	0.35 to 0.70%
Phosphorus	0.05% maximum
Sulphur	0.05% maximum
Chromium	0.7 to 1.25
Molybdenum	0.4 to 0.7%
(2) Carbon	0.15% maximum
Silicon	0.10 to 0.50%
Manganese	0.35 to 0.70%
Phosphorus	0.04% maximum
Sulphur	0.04% maximum
Chromium	2.0 to 2.5%
Molybdenum	0.9 to 1.2%

Mechanical Properties at 20° (68°F)

Kind of Steel	Tensile strength minimum		*elongation on $\frac{L_0 = 5 d_0}{L_0 = 5.65 \sqrt{A_0}}$ or % minimum.
	kg/mm.	tons/sq.in	
Carbon Steels			
(1)	31.5	20	25
(2)	45	28	21
Manganese Steels			
(1)	47	30	23
(2)	52	33	19
Molybdenum Steels	37.5	24	22
Chromium-Molybdenum Steels			
(1)	39	25	20
(2)	39	25	20

*Note L_0 = original gauge length ;
 d_0 = original diameter and
 A_0 = original area of cross section."

(19) in regulation 270(a), for the connotation for 'E', the following shall be substituted, namely:—

"E—the efficiency of ligaments between tube holes or other openings in shell or the weld factor of the longitudinal joint (expressed as a fraction), whichever applies.

The weld factor shall not be taken as more than 0.95."

(20) for regulation 271, the following regulation shall be substituted, namely:—

"271. Permissible working stresses for shells of Boiler and Integral Superheater Drums and Headers.—

The maximum permissible stress for drum shells and headers shall be the least of the values determined on the following basis:—

(i) For temperatures at or below 350°C (662°F), the smaller of the two values,

$$f = \frac{Et}{1.6} \quad \text{or} \quad \frac{R}{3.5}$$

(NOTE:—The ratio E/R shall not exceed 0.6 for Carbon Steels and 0.7 for Alloy Steels).

(ii) For temperatures above 350°C (662°F), the least of the following three values:—

$$(a) \quad \frac{Et}{1.6} \quad (b) \quad \frac{SR}{1.6} \quad \text{and} \quad (c) \quad Sc$$

Where,

t=Working metal temperature.

R=minimum tensile strength of the steel at room temperature.

E=Yield point at room temperature.

Et=Yield Point (0.2% proof stress) at the temperature t.

Sc=The average stress to produce a creep elongation of 1% (creep) in 100,000 hours at temperature t.

SR=The average stress to produce rupture in 100,000 hours at the temperature 't' and in no case more than 1.33 times the lowest stress to produce rupture at the temperature t.

For fusion welded drums, when the wall thickness exceeds 60 mm. (2½"), a deduction of 1 per cent in the value of 'f' so determined shall be made for each increase of 5 mm. (3/16") in the thickness.

(21) In regulation 278, (i) for the connotation for 'f', the following shall be substituted, namely:—

"f=permissible stress at working metal temperature of the drum-end plate (to be calculated on the basis prescribed under Regulation 271.)";

(ii) the table for permissible stress shall be omitted;

(22) The following provision shall be added in the last paragraph to regulation 293(a), namely:—

"If a part of the total area 'A' as determined by the above equation is provided in the valves fitted to integral superheaters, this part of the area shall be increased as provided for in equation 79."

(23) In regulation 338, —(i) for clause (a), the following clause shall be substituted namely:—

"(a) The working pressure of the tubes shall be determined by the following formula :—

$$WP = \frac{2f(T-C)}{(D-T+C)}$$

where,

T=Minimum thickness of tubes, that is, nominal thickness less the permissible negative tolerances.

C=1 mm. (0.04") for values of W.P. upto and including 70 kg. cm² (1000 lb./sq. in.)

=0.9 mm. (0.035") for values of W.P. over 70 kg. cm² (1000 lb./sq. in.) and upto and including 105 kg. cm² (1500 lb./sq. in.)

C=0.6 mm. (0.025") for values of W.P. over 105 kg./cm² (1500 lb. sq. in.)

W.P.=Working Pressure of boiler.

D=External diameter of tube.

f = Permissible Stress for the material of the tube at the working metal temperature, to be determined on the basis given below.

The working metal temperature shall be taken as:

- For integral economiser tubes, the maximum water temperature for which the part of the element is designed plus 11°C (20°F).
- For furnace and boiler tubes, the saturation temperature corresponding to the working pressure plus 28°C (5°F).
- For convection superheater tubes, the maximum steam temperature for which the part of the element is designed plus 39°C (70°F).
- For radiant superheater tubes, the designed maximum steam temperature plus 50°C (90°F).

Permissible Working Stress for tubes:—

For temperature at or below 350°C (662°F). T.S. or
 $\frac{3.5}{Et}$ whichever
 1.6 is the lower

For temperature above 350°C (662°F) Et or $\frac{SR}{1.6}$ or Sc
 1.6 whichever is the lowest.

Where,

TS = Minimum tensile strength of the material at room temperature.

Et = yield point (0.2% Proof Stress) at working metal temperature.

SR = the average stress to produce rupture in 100,000 hours and in no case more than 1.33 times the lowest stress to produce rupture, at the working metal temperature.

Sc = the average stress to produce an elongation of 1% (creep) in 100,000 hours, at the working metal temperature.

(ii) for clause (b), the following clause shall be substituted, namely:—

"(b) In no case, however, shall the thickness of tubes as supplied be less than those given in the table below (subject to tolerances specified in Regulations 36(d), 43(d), 48(c), 53(c); 56A(IV) and 58(d):"

TABLE

Outside diameter	Seamless Hot finished	Seamless Cold drawn or electric resistance welded
Upto and including 32 mm (1 1/4")	2.9 mm (0.116 in.)	2.03 mm (0.08 in.)
Upto and including 51 mm (2")	3.25 mm (0.128 in.)	2.34 mm (0.092 in.)
Over 51 mm (2 in.) upto and including 76 mm (3 in.)	3.25 mm (0.128 in.)	2.64 mm (0.104 in.)
Over 76 mm (3 in.) upto and including 89 mm (3 1/2 in.)	3.25 mm (0.128 in.)	3.25 mm (0.128 in.)
Over 89 mm (3 1/2 in.) upto and including 114 mm (4 1/2 in.)	3.66 mm (0.144 in.)	3.66 mm (0.144 in.)

In the case of coiled tubes for boilers of the forced flow or forced circulation type, the minimum thickness of tubes as supplied may, however, be as follows:—

Outside diameter of tubes in inches	Minimum thickness
Upto and including 29 mm (1-1/8")	1.62 mm (0.064")
Over 29 mm. upto and including 35 mm. (1-3/8")	1.83 mm. (0.072")
Over 35 mm (1-3/8") up to and including 42 mm (1-5/8")	2.34 mm (0.092")

(iii) for clause (c), the following clause shall be substituted, namely:—

"(c) Where tubes are bent, care shall be taken to ensure that the total strain at the bend is not more than that at the straight part of the tube.

The deviation from circularity in percentage at any cross section of a bend shall be calculated by the following formula:—

$$C = \frac{D_{\max} - D_{\min}}{D} \times 100$$

This deviation shall not exceed $\frac{20D}{R}$

where

C=The percentage deviation of circularity.

D_{max}=maximum external diameter of the tube as gauged at the bend.

D_{min}=minimum external diameter of the tube as gauged at the end.

D=nominal external diameter of the tube.

R=Radius of the bend on the central line of the bend."

(24) In regulation 340,—

(i) for clause (a), the following clause shall be substituted, namely:—

"(a) The working pressure shall not exceed the smaller of the values obtained from the following formulae:

$$(i) \quad WP = \frac{cf (t-c_1)^2}{b^2} \quad \text{Eqn. 88(a)}$$

$$(ii) \quad WP = \frac{6.25 t^2 f E}{W^2} \quad \text{Eqn. 88(b)}$$

where,

W.P. =working pressure.

t=thickness.

b=internal breadth between the supporting sides of the header.

c=3.413 for wrought steel and 2.926 for steel castings;

where the sides are corrugated or otherwise reinforced by substantial supports so that the length of the portion between the corrugations or supports does not exceed b, c shall be taken as 5.82 for wrought steel and 5.12 for steel castings.

f=permissible stress at working metal temperature as given in the table under clause 'c'

c₁=0.08 cm. (0.03 in.)

w=internal width of the header between the tube plate and the opposite side.

E=efficiency of ligaments between the holes."

(ii) for clause (b), the following clause shall be substituted, namely:—

"(b) If the faces of the headers are machined locally at the tube holes or hand holes the thickness at that part may be as much as 4.8 mm. (3/16 in.) less than given by the above equation; but irrespective of

the thickness obtained by the use of the formulæ, the thickness of the headers at the tube holes shall be not less than:

$$t = \sqrt{C_1 \times d} + C_2 \quad \text{Eqn. (89)}$$

where,

t = thickness

d = diameter of the hole

$C_1 = 0.2235 \text{ mm. (0.0088 in.)}$

$C_2 = 6.4 \text{ mm. (}\frac{1}{4}\text{ in.)}$

In no case shall the thickness be less than 8 mm. (5/16 in.), except that in small patches not exceeding 322mm² (one-half sq. in.) in area, the thickness may be 50 per cent of the thickness used in the equations 88(a) and 88(b)."

(iii) for clause (c), the following clause shall be substituted, namely:—

"(c) The permissible stress at working metal temperature shall be as given in the table below:

TABLE

PERMISSIBLE STRESS AT WORKING METAL TEMPERATURE FOR
RECTANGULAR SECTION HEADERS

Working Metal Temperature in degrees		Cast steel 44-55 kg mm ² (28 to 35 tons/ sq. in.)		Carbon and Alloy Steels
C	F	Kg/cm ²	lbs/sq. in.	
288	550	703	10,000	The lowest value obtained in each case at the specified temperature calculated on the following basis :— For temperatures at or below 250°C (482°F) T.S. 4
316	600	633	9000	For temperatures above 250°C (482°F)
343	650	562	8000	and at or below 350°C (662°F) . . (a) T.S. 3.5
				(b) $\frac{Et}{1.6}$
371	760	532	7560	For temperatures above 350°C (662°F) (a) $\frac{Et}{1.6}$
399	750	505	7200	
427	800	475	6750	
454	850	443	6300	(b) $\frac{SR}{1.6}$
482	900	309	4400	(c) Sc

Where,

T.S.—Minimum tensile strength of the material at room temperature.

Et—Yield point (0.2% proof stress) at the working metal temperature t .

SR—The average stress at the temperature ' t ' to produce rupture in 100,000 hours and in no case more than 1.33 times the lowest stress to produce the rupture in 100,000 hours.

Sc—The average stress at the temperature ' t ' to produce an elongation of 1% (creep) in 100,000 hours,

(iii) for clause (d), the following clause shall be substituted, namely:—

“(d) The working metal temperature shall be taken as:—

For saturated steam and water drums and headers the saturation temperature corresponding to the working pressure of the boiler plus 28°C (50°F).

For superheater headers the designed maximum steam temperature for the header plus 28°C (50°F).”

(25) for the Table under and the note below regulation 506(a), the following Table and note shall respectively be substituted, namely:—

“TABLE

Material for tubes and other pressure parts	Minimum tensile strength		Transverse test on span of 45·8 Cm (18 in.)			
			Minimum transverse breaking load in		Minimum deflection in	
	kg/mm ²	Tons/sq. in.	kg	lbs.	Cms.	inches
Grade 16·5 iron . . .	26·00	16·5	1052	2320	0·434	0·17
Grade 14 iron . . .	22·00	14·0	934	2060	0·407	0·16
Grade 12 iron . . .	18·75	12·0	839	1850	0·382	0·15”

“NOTE:—Grade 16·5, 14 and 12 iron correspond to 26, 22 and 18·75 kg/cm² (16·5, 14 and 12 tons) minimum tensile strength respectively.”

(26) for regulation 514, the following regulation shall be substituted, namely:—

“514. Tubes: Working Pressure.—The working pressure of the tubes shall be calculated in accordance with Regulation 338(a), but the working metal temperature shall be taken as the maximum water temperature for which the part of the element is designed plus 11°C (20°F).”

(27) in regulation 525(b),—

(a) for the heading to sub-clause (i), the following shall be substituted, namely:—

“Cast Iron Smooth Tube Economisers with Pressed Socket Joints.”

(b) in sub-clause (iii), (iv), (v) and (vi); for the values of ‘K’; the following shall be substituted, namely:—

K = 265 for Grade 16·5 Iron.

= 240 for Grade 14 Iron.

= 220 for Grade 12 Iron.”

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